Mound Systems

Recommended Standards and Guidance for
Performance, Application, Design, and Operation and Maintenance

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Formula on page 36, C.2.a., corrected.

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Health

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Preface

The recommended standards contained in this document have been developed for statewide application. Regional differences may, however, result in application of this technology in a manner different than it is presented here. In some localities, greater allowances than those described here may reasonably be granted. In other localities, allowances that are provided for in this document may be restricted. In either setting, the local health officer has full authority in the application of this technology, consistent with Chapter 246-272 WAC and local jurisdictional rules. If any provision of these recommended standards is inconsistent with local jurisdictional rules, regulations, ordinances, policies, procedures, or practices, the local standards take precedence. Application of the recommended standards presented here is at the full discretion of the local health officer.

Local jurisdictional application of these recommended standards may be:

1) **Adopted as part of local rules, regulations or ordinances—**When the recommended standards, either as they are written or modified to more accurately reflect local conditions, are adopted as part of the local rules, their application is governed by local rule authority.

2) **Referred to as technical guidance in the application of the technology—**The recommended standards, either as they are written or modified to more accurately reflect local conditions, may be used locally as technical guidance.

Application of these recommended standards may occur in a manner that combines these two approaches. How these recommended standards are applied at the local jurisdictional level remains at the discretion of the local health officer and the local board of health.

The recommended standards presented here are provided in typical rule language to assist those local jurisdictions where adoption in local rules is the preferred option. Other information and guidance is presented in text boxes with a modified font style to easily distinguish it from the recommended standards.

Acknowledgements—

The Department of Health Wastewater Management Program appreciates the contribution of many persons in the on-going development, review, and up dating of the Recommended Standards and Guidance documents. The quality of this effort is much improved by the dedication, energy, and input from these persons, including:

- Geoflow, Inc.
- Lombardi and Associates
- Orenco Systems, Inc.
- Puget Sound Water Quality Action Team
- Sun-Mar Corporation
- Washington State On-Site Sewage Association (WOSSA)
- Washington State On-Site Sewage Treatment Technical Review Committee (TRC)
- Waste Water Technologies

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Introduction—

A mound system is characterized by:

- a pretreatment device (usually a septic tank, conventionally sized),
- pressure distribution components (pump chamber, pump and controls, and low-pressure distribution laterals), and
- the "mound" (Fig. 1). The "mound" consists of:
  - filter media,
  - an infiltration bed,
  - a distribution system, and
  - a soil cap and topsoil cover.

Septic tank effluent, pumped from the pump chamber to the distribution system in the infiltration bed flows through the filter media where it undergoes biological and chemical treatment and then passes directly into the underlying natural soil for disposal.

Mounds are an excellent treatment and disposal choice on appropriate sites, but they are not very forgiving. Special attention must be given to siting, design, pre-construction planning, site preparation, filter media selection, construction and maintenance of these systems. Quality control throughout the process cannot be overemphasized.

Specifically speaking, the following items / issues are the "Critical Items" to address when applying mound technology:

- **Suitable siting / application of the mound system technology, to both the site and the project.**

- **Accurate soil type and soil depth determination.**

- **Rigid adherence to the design concept that mounds must be "long and narrow" and located only along the topographical contours of the site.**

- **Mound systems have specific siting, design, construction, and maintenance conditions which when not fully met, lead to operational problems.**

- **Careful selection and placement of filter media.**

Typical Applications of Mound Systems—

Mound system design has been developed for those site conditions in which a two-foot vertical separation can not be maintained between the bottom of a SSAS and a restrictive layer of rock, clay, or water table. Mound system design addresses the following site and soil conditions.

Other types and combination of alternative treatment and disposal systems are also suitable for these difficult site development conditions. Other alternative systems to be considered include sand filters and aerobic treatment devices with shallow or at-grade drainfield systems, using gravel-filled and gravelless drainfield designs and products. Note: At-grade drainfields are being evaluated by DOH with possible development and release of Recommended Standards and Guidance by December 31, 1999.

- **Permeable or slowly permeable soils with a high water table.**

  Whether the water table is seasonal or permanent, these soils have inadequate vertical separation to provide satisfactory treatment with conventional systems. Elevated water table may be due to landscape position, slow soil permeability, or a shallow restrictive layer that inhibits downward water movement.

  The mound system addresses these conditions by elevating the infiltration bed to achieve the needed vertical separation. By using uniform distribution and adequate vertical separation in the selected filter media, vertical unsaturated flow is maintained, thus ensuring the maximum treatment permitted by this technology. Figure 2 shows typical effluent movement through this system.

- **Excessively permeable soils over unprotected aquifers or shallow permeable soils overlying excessively permeable soils or creviced or porous bedrock.**

  These sites present the risk of inadequate wastewater treatment before it reaches unprotected aquifers in excessively permeable conditions. This represents a significant public health risk.

  The mound system helps assure a known level of wastewater treatment before it is discharged to the sub-soil. Figure 2 shows the typical effluent movement through this system, with most of the flow being downward.

- **Slowly permeable soils without a high water table.**

  These soils are subject to severe damage from smearing and compaction, especially during the construction of conventional systems, which drastically reduces the permeability of the soil by destroying water moving pores and channels. As a result these sites present a high potential for site and soil interface damage in addition to the need for large drainfields to provide adequate infiltration area. The advantages of a mound system for these sites are:

  - The mound effluent enters the more permeable natural topsoil over a larger area where it can move laterally until absorbed by the less permeable subsoil (Fig. 3).

  - The bio-mat that develops at the bottom of the infiltration area will not clog the filter media as readily as it would the less permeable natural soil.

  - The infiltration area within the filter media is much smaller than it would be if placed in the more slowly permeable subsoil although the total mound area is probably larger than would be for a conventional drainfield system if one could be used.

Mound systems are used primarily in shallow soils overlying a restrictive layer or elevated groundwater table. The shallower the soil the more attention must be paid to transporting the treated effluent away from the point of application. Some of the principles that control the movement of treated effluent under and away from the mound (or any other disposal system) include:

- **Groundwater mounding**

  Under any trench or bed treated effluent will accumulate as the system is used. This accumulation, called a "groundwater mound" will form on top of the restrictive layer or water table. The height of this groundwater mound is governed by the slope or gradient it generates. The slope must increase until it is great enough to drive the water away as fast as it is added. The concern here is that the groundwater mound may accumulate to such a degree as to severely reduce—or eliminate—the unsaturated vertical separation critical to provide treatment.

- The tighter the soil, the steeper the slope the groundwater mound of treated effluent must have in order to drive a given amount of treated effluent through a given area.

- The slope of the restrictive layer acts like, and is additive to, the slope of the groundwater mound of effluent. The slope of the ground surface is an indicator of the slope of the restrictive layer provided that the restrictive layer is relatively parallel to the ground surface.

Consideration of these principles mandates that on any site, under any conditions, the mound system must be long and narrow and placed only along the contours of the site / slope.

1. Performance Standards—

1.1. Performance Criteria—

1.1.1. When properly sited, designed, installed, operated and maintained, a mound system consistent with these recommended standards and guidance is expected to achieve treatment performance equal to Treatment Standard 2.

1.1.2. When preceded by an intermittent sand filter or other treatment unit listed (List of Approved Systems and Products) as meeting all three parameters of Treatment Standard 2, a mound system (properly sited, designed, installed, operated and maintained in a manner consistent with these recommended standards and guidance) is expected to achieve treatment performance equal to Treatment Standard 1.

The use of mounds to meet Treatment Standard 1 or 2 is limited in Chapter 246-272 WAC. Table VI prohibits the use of mounds to meet TS 2 due to the possible severe site limitations presented by repair or replacement of failing on-site sewage systems. Mounds are a poor choice on sites where either or both the vertical separation and the horizontal separation is severely limited (such as less than 12" VS or less than 25 feet HS).

1.2. Listing—Mounds are a generic alternative technology and therefore are not listed in the List of Approved Systems and Products, but may be permitted by local health officers as there are recommended standards and guidance from DOH.

2. Application Standards—

2.1. Permitting—

2.1.1. Permitting and installation of mound systems are subject to local and state code.

2.1.2. An installation permit, and if required, an operational permit, must be obtained from the appropriate local health officer prior to installation and use. For sites where either Treatment Standard 1 or 2 must be met, some means acceptable to the local health jurisdiction must be implemented to assure proper on-going operation and maintenance (O&M) of the system components as long as the facility is served by the on-site sewage system. The following options may be used separately or in combination. Approaches to assuring long-term O&M include:

(a) recording the requirement for an on-going service contract on the property deed;

(b) issuing an operating permit (in addition to the initial installation permit), with the requirement for maintaining a service contract; and,

(c) requiring a management entity to provide O&M assurance. Examples of management entities include: cities & towns, public utility districts, water & sewer districts, special-use districts, and corporations and home-owner associations with demonstrated capacity to assure long-term management.

2.2. Mound location—Locate the mound in open areas for exposure to sun and wind where evaporation and transpiration will be maximized.

2.2.1. Do not construct mound systems in drainage ways, depressions, or areas subject to flooding.

(a) Upslope runoff must be diverted around the mound.

(b) Good design practice must consider drainage constraints for both upgradient and downgradient area drainage. The Health Officer may require additional site evaluations and/or testing to analyze the site before siting the mound system.

A crested site is the most desirable because the mound can be situated such that the effluent can move laterally down both slopes. The level site allows lateral flow in all directions, but may present problems as the groundwater mound that develops under the mound may rise to the ground surface beneath the mound in slowly permeable soils. The most common application is the sloping site where all the liquid moves in one direction away from the mound (Fig. 3). However, proper design can overcome this limitation. The mound should be placed on the upper portions of the slope, not at the base of the slope. On a site with a complex slope (two directions), the mound should be located so that the treated wastewater is not concentrated in one area downslope.

Sites with large trees, numerous smaller trees or large boulders are less desirable for installing a mound system because of difficulty in preparing the surface and because of the reduced infiltration area (exposed soil) available beneath the mound. Tree roots, stumps and boulders are like rock fragments, they occupy space, and thus reduce the amount of soil available for receiving and transmitting treated wastewater away from the mound area.

If no other site is available, leave the tree stumps cut off at ground level rather than disturbing the native soil by removing them. A larger-than-normal mound area may be necessary if many, or large, stumps or boulders are involved, so sufficient soil is available to accept the effluent. The amount of increased basal area and/or mound size should be technically justified and sufficient to make up for the soil infiltration area lost to the tree trunks, stumps, and boulders.

In addition to increasing the size of the system extra care and consideration must be given to adequately prepare the soil infiltrative surface under less-than-ideal conditions. Such a site may very well necessitate meticulous hand spading of part or all of the area under the mound. Like the amount of additional area required to make up for the lost infiltration area, the method employed and care required to satisfactorily prepare the site is a designer's responsibility.

2.3. Minimum Soil Depth—

2.3.1. A minimum of 18 inches of undisturbed, unsaturated, original soil as measured from ground surface is required for placement of a mound. A minimum of 12 inches of undisturbed, unsaturated, original soil is required when the mound is preceded by an intermittent sand filter or other pre-treatment unit identified on the List of Approved Systems and Products as meeting all three parameters of Treatment Standard 2.

2.3.2. If the restrictive characteristic is a high water table and there is not agreement among the various development parties that there is at least 18 inches of soil above it, the maximum high water table must be determined during the high water table season. In all cases, high water table season checks must be made if there may be less than 18 inches of soil.

Generally, when vertical separation (or in the case of mounds, soil depth) is suspected to be less than 24 inches high water table season checks are required by local health jurisdictions to accurately identify the location of high water tables. As potential vertical separation (or soil depth) decreases seasonal site checks to evaluate water table levels become increasingly critical to the on-site sewage system design, function, and to the protection of public health.

2.4. Ground Slope Limitations—The maximum ground slope on which a mound can be reasonably installed with customary construction equipment is 20%.

Design and placement of mounds on slopes greater than 20% mandates that special care and consideration be given to slope stability, installation techniques, and design elements of "long & narrow". These issues may require the services of qualified / experienced engineers, geologists, soil scientists, or others, depending upon the site conditions.

2.5. Setbacks—Setbacks are measured between the perimeter of the basal area of the filter media and the respective features. Table 1, Appendix A, describes mound setbacks. Other minimum setbacks are as specified in WAC 246-272-09501 Location.

2.6. Influent Characteristics—

2.6.1. Wastewater from residential sources must receive pre-treatment at least equal to that provided in a conventional two-compartment septic tank, before discharge to a mound.

2.6.2. Wastewater from non-residential sources, or high-strength wastewater from residential sources must receive pre-treatment sufficient to lower the waste-strength to the level of that commonly found in domestic residential septic tank effluent before discharge to a mound.

When addressing unique wastewater strengths from the septic tank, such as those characterized by high BOD_5 or TSS or oil and grease, be advised that like the intermittent sand filter, the mound system has inherent limitations when treating wastewater that is higher in strength than what is considered normal domestic wastewater. The wastewater applied to the mound should not be higher in strength than 220 mg/l BOD_5 or 145 mg/l TSS. Lower wastewater strengths, without increased flow rates, is preferable for assuring long-term operation of a mound system. High-strength wastewater and wastewater from non-domestic sources (such as restaurants, hotels, bed and breakfast establishments, industrial and commercial wastewater sources, etc.) should be individually evaluated for treatability and degree of pretreatment required prior to a mound for final treatment and disposal.

2.7. Minimum Land Area / Density—The use of a mound system does not provide for a reduction in the minimum land area requirements established in WAC 246-272-20501. Site development incorporating a mound must meet the minimum land area requirements established in state and local codes.

2.8. Reserve Area—A reserve area with suitable site conditions for a mound installation must be set aside. The reserve area must:

2.8.1. be equal to 100 percent of the normally required mound area

2.8.2. be totally separate from the initial mound area,

2.8.3. be able to meet all of the design requirements, including soil depth, soil type, slope restrictions, and set-backs, etc. and

2.8.4. remain fully protected to prevent damage to soil and any adverse impact on the immediate surroundings that may affect the installation of the replacement mound system or its function.

2.9. Installation—

2.9.1. Equipment—

(a) A tracked vehicle with a maximum pressure on the soil of 7 psi must be used to place the filter media, prepare the bed, shape the mound and add the topsoil cover. A wheeled vehicle must not be used for this work, or travel over the basal area or the area included within 30 feet downslope of the basal area.

> *Given the make and model of equipment, a manufacturer can provide the psi of a tracks. Proper installation techniques also require prudent maneuvering over the fill material, such as not leaving the equipment parked and running while on the fill and not performing locked track turns on the fill. Both of these and certain other practices can compact the soil under the fill.*

(b) A spring-loaded agricultural chisel plow, or other acceptable apparatus or method, must be used to prepare the soil before constructing the mound system (See Appendix F. Site Preparation and Construction). Rototilling is not an acceptable substitute and must not be used.

2.10. Inspection—All site inspections before, during, and after construction of the mound system must be accomplished by the local health officer or other appropriate jurisdictional representative, or by a person (designer or engineer) identified and approved by the appropriate jurisdictional authority.

2.11. Gravel Material— Washed and clean, non-deteriorating, drain rock meeting at least the Washington State Department of Transportation Standards For Coarse Aggregate (no more than 0.5% passing a 200 sieve) must be used.

2.12. Gravelless Drainfields—Gravelless drainfield products may be used in place of gravel in mound systems. Only those gravelless drainfield products on the current List of Approved System and Products may be permitted by the local health jurisdiction.

2.13. Mound Filter Media—

2.13.1. Mound filter media is ASTM C-33 sand as described in Appendix H.

2.13.2. Due to the limited experience with other grade materials, other filter media must not be used.

> *Quality filter media and its careful placement, two of the most important and costly components of the mound system, are essential for long-term performance. To assure quality control of the filter media the following suggestions are made to the designer and installer:*
>
> *1) Require that the filter media supplier or manufacturer provide written certification that the sand product conforms to the ASTM C-33 specifications (See Appendix H) as documented by a textural (sieve) analysis; and,*
>
> *2) Evaluate each truckload of filter media at the construction site to check that each load is the material ordered. Wide variations in the product or substitution with non-conforming sand material have been demonstrated to contribute to mound system failures.*
>
> *It should be noted that few naturally occurring sands would meet this specification. Most concrete sands available from commercial sources are manufactured using a series of sieves.*

2.13.3 In order to prevent differential settling when the mound is put into service, the filter media must have a uniform density throughout.

> *Uniform density may be accomplished one of two ways, depending on the moisture content of the filter media during construction. If the filter media is so dry that it can be poured (like salt or sand in an hourglass), it can simply be poured or pushed with a tracked vehicle into position, then settled lightly (not compacted) to allow about 5% settling-i.e., volume reduction. However, if the filter media is moist enough that it cannot be poured, it should be placed in successive 6-inch lifts with each lift lightly settled. The intent of the light settling in both cases is eliminate large voids in the media that may collapse later when effluent is added. The light settling may be accomplished by walking on the sand and around monitoring ports. The final bulk density should be approximately 1.3 to 1.4 g/cm^3 (81.2 to 87.4 lb/ft^3). Higher densities will reduce infiltration rates and oxygen exchange potential.*

3. Design Standards—

3.1. Design Approval—

3.1.1. Mound systems must be designed by a qualified professional engineer, registered sanitarian, or approved designer, depending upon jurisdictional agency requirements.

3.1.2. A representative of the local health jurisdiction must approve mound system designs before construction is started.

> *These recommended standards provide a systematic approach to mound system design for typical domestic household wastewater. For systems serving other than single-family dwellings the designer is cautioned that simple extrapolation of this information may not be appropriate. As daily wastewater flows increase beyond single-family levels table values and pre-calculated charts cannot be relied upon solely, and should be carefully confirmed by individual calculations.*

3.2. Daily Design Flow - Daily design flow (gal/day) = Number of bedrooms x 120 gal/day.

3.3. Application Rates—

3.3.1. The application rate for the mound infiltration area (gravel bed) varies with the level of pretreatment.

(a) When pretreatment is provided by an approved two-compartment septic tank, the application rate must not exceed 1.0 GPD/Sq. Ft.

> *The loading rate to the C-33 sand in mounds is 1.0 gpd/ft^2 rather than the 1.2 used in other sand-based systems due to the observation that many mounds are failing at the gravel-sand interface. The TRC recommended this more conservative approach to counter this tendency. It should be noted that in Wisconsin, sand systems are never loaded greater than 1.0 and often area designed at 0.8.*

(b) When pretreatment is provided by an approved pre-treatment unit identified on the List of Approved Systems and Products as meeting all three parameters of Treatment Standard 2, the application rate may exceed 1.0 GPD/ft^2 but must not exceed 2.0 GPD/ft^2 when the following conditions are met.

The maximum infiltration area (gravel bed) width is no greater than 50% of that identified in Table 2. Maximum Bed Width.

There is no reduction in the length of the bed (same as it would be if designed at 1.0 GPD/Sq. Ft.).

There is no reduction in the required size of the basal area (sized according to Appendix B, Table 4.)

3.3.2. The application rate for the basal area varies with Soil Type. See Appendix B, Table 4.

Sites must be critically evaluated for their suitability for a mound system. The soil depth and/or water table conditions might necessitate consideration of a mound for a particular site but the overall site may not be a suitable application of the technology. Mound location, topography of the site, upland conditions, encroachments, surface water flow, soil type and structure, hydraulic conductivity, etc. are but a few of the critical issues to address on every proposed mound site.

Lots or sites that are forested or heavily covered with underbrush make this process very difficult, if not virtually impossible. As accurate soil depth assessment is essential, sites that do not lend themselves to clear evaluation must be adequately brushed and cleared before soils evaluation.

The clearing performed must be representative of the extent of site and soil disturbance anticipated with the future development and construction. This will help assure that the conditions that exist at the time of the mound system installation will be the same as those that existed at the time of the site / soil evaluation. Furthermore, the initial mound site, the replacement area, and the 30 foot protected zone downslope from both mounds must be adequately protected during site development to assure that the site / soil conditions will remain compatible with the approved design and construction plan throughout the project.

3.4. Mound Configuration—The configuration of the mound system responds to the slope, shape, size, and feature characteristics of the site, and is determined by the rectangular dimensions of the infiltration bed in response to the depth of unsaturated soil (see Table 1).

3.5. Infiltration Area (gravel bed)— The size of the infiltration area (the bottom infiltrative surface area of the bed) is determined by applying the following formula:

$$\text{Infiltrative Surface Area (ft}^2\text{)} = \frac{\text{Daily design flow (gal/day)}}{1.0 \text{ gallons/ft}^2\text{/day}}$$

3.5.1. Bed Width—Soil Type and depth are matched, establishing maximum infiltration bed widths in Table 2, Appendix B.

<u>Bed width (A)</u> = Dependent on soil depth. See Table 2

3.5.2. Bed Length— The length of the infiltration area (the bottom infiltrative surface area of the bed) is determined by applying the following formula:

$$\underline{\text{Bed length (B)}} = \frac{\text{Required bottom infiltrative surface area}}{\text{Bed width (A)}}$$

3.5.3. Bed Depth—A minimum of 6 inches of aggregate is placed beneath the distribution pipe, 2 inches above the pipe.

<u>Bed depth (F)</u> = 9 inches (minimum for 1-inch lateral)

3.5.4. Bed Grade—The bottom of the bed must be level ($\pm$1/2 inch).

3.6. Mound Height—The mound height consists of:

3.6.1. the filter media depth below the bottom of the bed (D & E),

3.6.2. the infiltrative bed depth (F), and

3.6.3. the cap and topsoil depth (G & H).

3.7. Filter Media Depth—The depth of filter media is dependent upon the treatment capabilities and characteristics of a given site. A minimum unsaturated flow depth of 3 feet of soil is required. This depth may consist of the natural soil and mound filter media.

3.7.1. There must always be a minimum depth of 12 inches of filter media under all parts of the bed regardless of the level of pretreatment Certain conditions require more filter media:

(a) If the native soil depth is between 18 and 24 inches, then the depth of filter media <u>plus</u> the native soil depth must equal 36 inches. However, if the mound is preceded by an intermittent sand filter or other pre-treatment unit identified on the List of Approved Systems and Products as meeting all three parameters of Treatment Standard 2, only 12 inches of filter media below the beds is required.

(b) If the original 2 feet of soil is Type 1A or 1B underlain by creviced or porous bedrock, 2 feet of filter media (D & E) is required between the bottom of the infiltrative bed and the original soil.

3.7.2. The depth of filter media below the infiltration bed varies with ground slope according to the following formulas:

<u>Filter media depth below upslope edge of bed (D)</u> =	1 to 2 feet
<u>Filter media depth below downslope edge of bed (E)</u> =	1 to 2 feet + [% natural slope as a decimal x width of bed (A)]

3.8. Filter Media Length and Width—The length and width of the filter media are dependent upon the length and width of the infiltration bed, filter media depth and side slopes of the filter media.

3.8.1. Side slopes must be no steeper than 3:1 (i.e. 3 feet of run to every 1 foot of rise) (Fig. 6). Soil having textures other than those used for the approved filter media may be used to make the slopes gentler (such as 4:1 to facilitate landscaping and lawn mowing) than the required 3:1 slopes, once the 3:1 slope exists with the filter media.

3.8.2. The filter media length consists of the end slopes (K) and the bed length (B).

3.8.3. The filter media width consists of the upslope width (J), the bed width (A), and the downslope width (I). On sloping sites the downslope width (I) will be greater than on a level site if a 3:1 side slope is maintained. Table 3 gives the slope correction factor (multiplier) for slopes from zero up to 20% with a 3:1 side slope.

3.9. Cap and Topsoil Depth—The soil placed over the entire mound must be selected and placed to promote aeration of the mound, rainwater movement off and away from the mound, and establishment and maintenance of a vegetative cover. The cap and topsoil may consist of filter media sand and medium-to-fine sandy loam.

3.9.1. The final settled depth of the topsoil cap should be no less than 12 inches above the center and 6 inches above the outer edge of the bed. Additional depth of topsoil must be placed during final construction activities to assure that the minimum depths are achieved following natural settling of the soil.

3.9.2. The depth and type of topsoil used must not adversely inhibit the free transfer of oxygen to the bed and filter media of the mound.

3.9.3. Cap and Top Soil (G & H):

<u>Unsettled cap and topsoil depth at bed center (H)</u> = 18 inches.

Unsettled cap and topsoil depth at bed edges (G) = 12 inches.

3.9.4. The mound must not be left without a vegetative cover or to go to weed. Turf grass or turf sod are the best vegetative covers for mounds.

The cap, usually consisting of a topsoil or subsoil, provides frost protection, a barrier to infiltration, retains moisture for vegetation and promotes runoff of precipitation. The topsoil aids in establishing and maintaining a good vegetative cover. The cap and topsoil will settle during construction and usage. It is important that the finished settled cap and topsoil promote runoff and contain no depressions. Some soils may settle a great deal so be sure to place adequate depth of soil to allow for settling in achieving the final settled depth of cap and topsoil.

The use of a fine textured soil will enhance moisture retention for plant growth and increased rainwater runoff. Exercise caution, however, so as not to use soils with such fine texture as to severely reduce oxygen transfer through the cap. Coarse textured soils, such as sands, are not recommended, as they drain rapidly and allow more intrusion of precipitation into the infiltration bed. Often, excavated soil from the site can be used.

Care and maintenance of the soil cover is important. Different sites will present different landscaping options for the mound, in terms of yard surface contouring and plantings. If landscaping is not going to occur soon after installation seeding with turf grass or placement of turf sod is highly recommended to hold the soil and prevent erosion. In any case the mound must not be left without a vegetative cover or to go to weed. Mounds without satisfactory vegetative cover are often damaged by children digging, small animal damage, livestock trampling, or erosion.

3.10. Basal Area—The amount of basal area required is dependent upon the permeability of the original soil. Table 4 gives the infiltration/loading rates for determining the needed basal area.

3.10.1. For level sites, the total basal area [length of filter media (L) x width of filter media (W)] beneath the filter media is available for effluent absorption into the soil. See Figure 8.

3.10.2. For sloping sites, the only available basal area is the area beneath the bed (A x B) and the area immediately downslope from the bed [bed length (B) x downslope width (I)]. It includes the area enclosed by [B x (A + I)]. See Figure 8. The upslope and end slopes will transmit very little of the effluent on sloping sites, and are therefore disregarded.

3.10.3. The available basal area must equal or exceed the required.

$$\text{Basal area required} = \frac{\text{Daily flow}}{\text{Infiltration rate of original soil}}$$

Basal area available = B x (A + I) on sloping site or
= L x W on level site.

The basal area is the interface between the natural soil and the filter media. Its function is to accept the effluent from the filter media, assist the filter media in treating the effluent, and transfer the effluent to the subsoil beneath the filter media for lateral movement to the subsoil outside of the mound.

If sufficient area is not available for the given design and site conditions, corrective action is required to increase the perimeters of the filter media area. The preferred method to increase basal area is to lengthen the bed rather than simply extending the toe of the filter media. Again, be advised that if a mound can not *be designed and laid-out "long and narrow" other enhanced treatment technologies should be selected rather than err in designing or locating a mound system.*

3.11. Mound Placement—The following design conventions for system layout and mound placement must be followed.

3.11.1. On sloping sites, the mound must be aligned with its longest dimension parallel to the contours so as not to concentrate the effluent into a small area as it moves laterally downslope.

3.11.2. The mound must not be aligned, by design or construction, perpendicular to the contours.

3.11.3. On all sites the infiltration bed must be as long and narrow as possible to limit the linear loading rate of effluent to assure that all the effluent infiltrates into the natural soil before it reaches the toe of the filter media.

3.11.4. If the site does not permit the design of a "long and narrow" mound along the contours of the site, other on-site sewage treatment and disposal technology must be selected. Mound systems are only suitable for sites where all of the design and siting criteria can be satisfactorily met.

3.11.5. Two or more beds on the same downhill plane are not permitted if the total bed width exceeds the specified maximum bed width in Table 2, unless the distance between beds is so great that a curtain drain meeting all the required setbacks can be properly installed between the farthest extensions of the two beds.

3.12. Pressure Distribution Network—A method providing uniform distribution throughout the bed in the filter media is required. The pump chamber and the distribution system must be designed in accordance with the Recommended Standard and Guidance for Pressure Distribution. Design, layout, and installation of the pump chamber-to-mound transmission line must consider, and satisfactorily address, the potential for channeling groundwater or surface water to either the mound or the pump chamber causing infiltration-related problems.

3.13. Monitoring Ports – Each mound fill should have a minimum of two monitoring ports, one placed in the infiltration bed down to the gravel-sand interface, and one downslope from the bed down to the sand-native soil interface. Another useful monitoring port would be installed through the sand-native soil interface into the native soil several inches. See Figure 9 for examples of monitoring ports and anchoring methods.

3.14. Construction Plan—A construction plan must be developed and submitted as a part of the project design. A construction plan includes, among other necessary details:

3.14.1. The routes for ingress and egress for construction vehicles, assuring that adequate protection is afforded the mound, and surrounding areas, especially downslope areas. The mound system, including the area around the base and downslope, must be protected to prevent damage caused by vehicular, livestock, or excessive pedestrian traffic.

3.14.2. The means to assure that the reserve area is not subject to damage or soil compaction from vehicular activity.

3.14.3. Instructions for erecting a temporary construction fence or protective barrier around the proposed mound, designated reserve, and the adjacent area (particularly downslope from the two mound sites) to assure that the area is not damaged by other construction activity before installation of the mound system. These areas must be unmistakably identified on the site so as to preclude potential site damage. Such fencing or identification is the responsibility of the sewage system designer.

3.14.4. Instructions, layout and specifications for proper grading, diking, ditching and subsurface drainage to prevent the intrusion of off-site surface and subsurface waters into the mound area, and

3.14.5. Requirements for proper installation equipment and construction procedures (See Appendix F. Site Preparation and Construction.

The procedures used in the construction of a mound system are just as critical as the design of the system. Good design with poor construction will result in system failure. It should be emphasized that the soil must only be worked when the moisture content is low to avoid compaction and puddling. Consequently, installations must be made only when the soil is as dry as required. The approved construction plan must be followed.

4. Operation & Maintenance Standards—

4.1. The system owner is responsible for the continuous operation and maintenance of the system.

4.2. The local health department or other appropriate jurisdiction may require third-party management of the on-site system. In such cases, the approved management entity must be responsible for the continuous operation and maintenance of the system and must submit appropriate records routinely to the local health or other appropriate jurisdiction.

4.3. O&M Activities / Schedules—Routine and preventative maintenance aspects are:

4.3.1. Scum and sludge levels in the septic tank or other pretreatment devices, as well as the pump or siphon chamber, should be inspected routinely and pumped when necessary. On an average, septic tanks should be pumped every 3 to 5 years.

4.3.2. Periodic inspections of system performance are required. Liquid levels in the standpipes should be checked and examinations made for any seepage around the toe of the mound.

4.3.3. A good water conservation plan within the house or establishment will help assure that the mound system will not be hydraulically overloaded.

4.3.4. Avoid traffic in the initial and replacement mound areas, in particular the area downslope from the mound and replacement mound. No vehicular or livestock traffic should be permitted. With lawn care equipment, such as riding lawn mowers or tractor, be careful not to travel on the mound, or the downslope area, when the soil is saturated, as during the wet wintertime. Winter traffic on the mound should be avoided to minimize frost penetration in colder climate areas and to minimize compaction in other areas.

4.4. Owner's Manual—A user's manual must accompany the mound system's construction plan and must be submitted to the local health department for approval. A copy of this manual must be given to the property owner after completion of the mound system. The manual must contain the following as a minimum:

4.4.1. Diagrams of all system components and their location. This should include the location of the reserve area.

4.4.2. Specifications for all electrical and mechanical components.

4.4.3. Names and phone numbers of local health authority, component manufacturer or management entity to be contacted in the event of an alarm, or other problems or failure.

4.4.4. Information on the periodic maintenance of the mound system, including electrical/mechanical components.

4.4.5. What activities can or cannot occur on and around the mound and the reserve area.

4.4.6. Information regarding suitable landscaping and vegetation for the mound and surrounding areas.

Three failure conditions may occur within the mound. They are (1) severe clogging at the bottom of the infiltration area, (2) severe clogging at the filter media and natural soil interface, and (3) plugging of the distribution network.

If severe clogging occurs at the bottom of the infiltration bed, its cause should first be determined. The most common cause is improper filter media with too many fines. Reduction in flow and/or expansion of the bed area may mitigate or alleviate the problem. In extreme cases, the filter media must be removed and replaced with new filter media or the mound system rebuilt on another site.

If the clogging is due to overloading or unusual wastewater characteristics, efforts should be made to reduce the wastewater volume or strength. It may be necessary to enlarge the mound. The mound cap should be removed and the aggregate in the infiltration bed stripped out. The area downslope of the mound should be prepared and additional filter media added to enlarge the mound to the proper size. The infiltration bed can then be reconstructed.

Severe clogging or hydraulic overloading at the mound and natural soil interface will cause surface seepage at the base of the mound. This area should be permitted to dry and the downslope area prepared and additional filter media added. If this does not correct the problem, the site may have to be abandoned.

Partial plugging of the distribution piping may be detected by extremely long dosing times or a decreased drawdown following the dose event (decrease from original settings). The ends of the distribution laterals should be exposed and the pump activated to flush out any solid material. If necessary, the pipe can be rodded.

Appendix A

Figures

Figure 1 — A cross-section of a septic tank-mound system for on-site disposal.

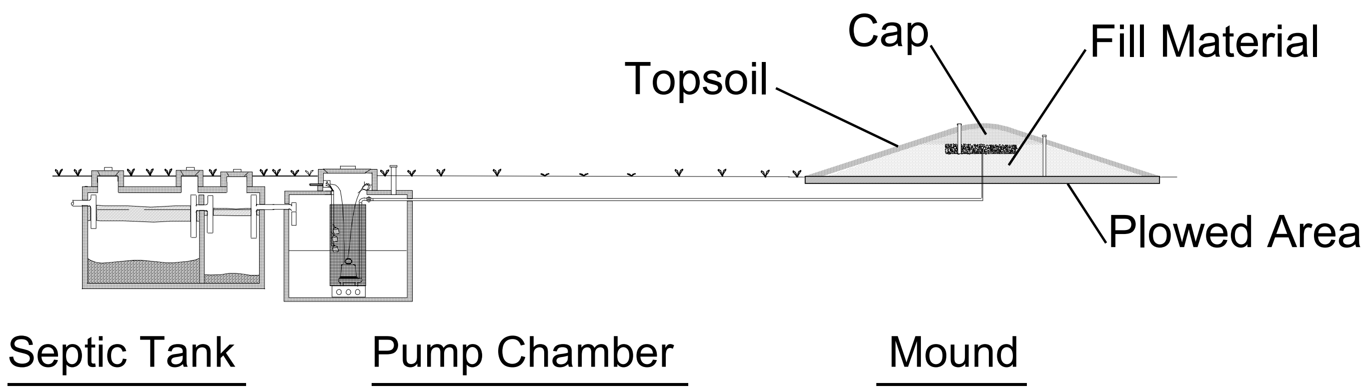


Figure 2 — A cross-section showing effluent movement in permeable or excessively permeable soils (Type One soils).

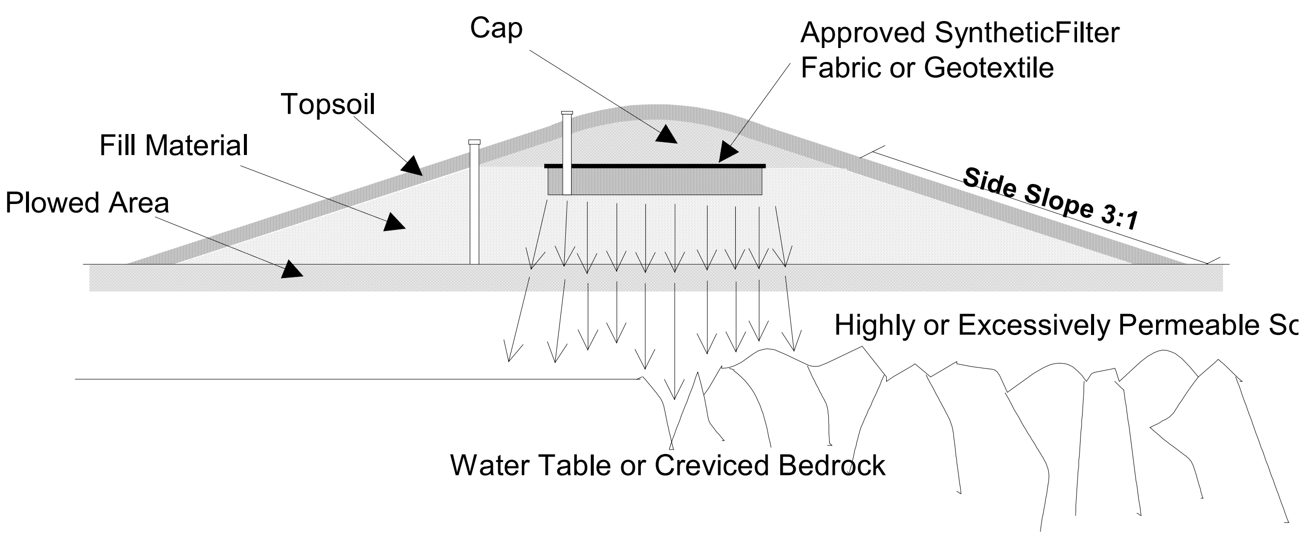


Figure 3 — A cross-section of a typical mound system showing effluent movement in a slowly permeable soil on a sloping site.

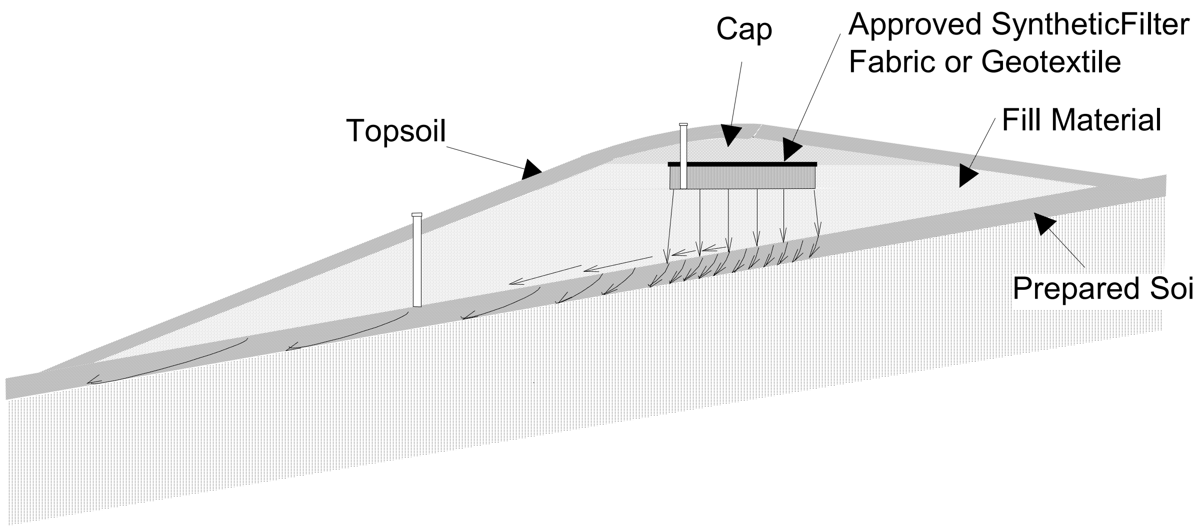


Figure 4 — Downslope setback from toe of basal area.

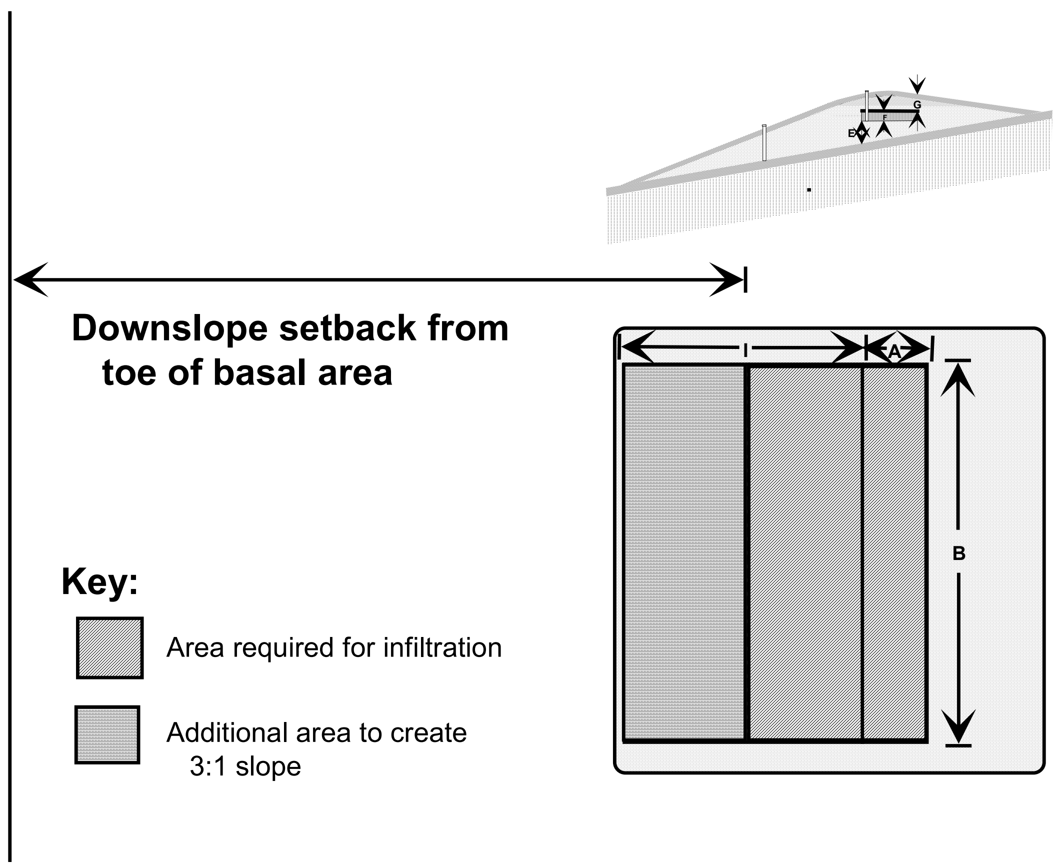


Figure 5 — Detailed plan view of filter media.

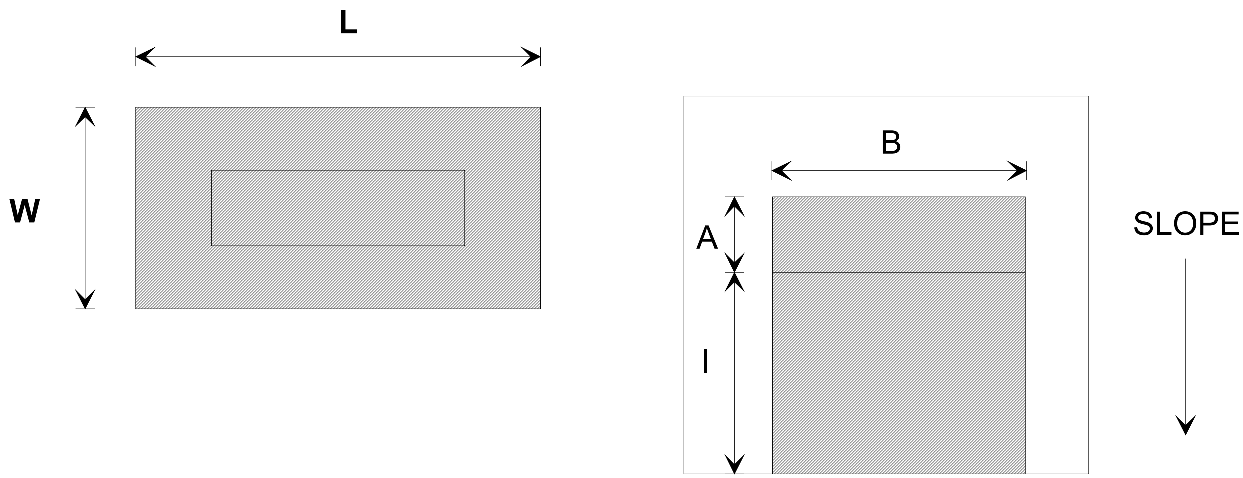


Figure 6 — Detailed cross-section of mound.

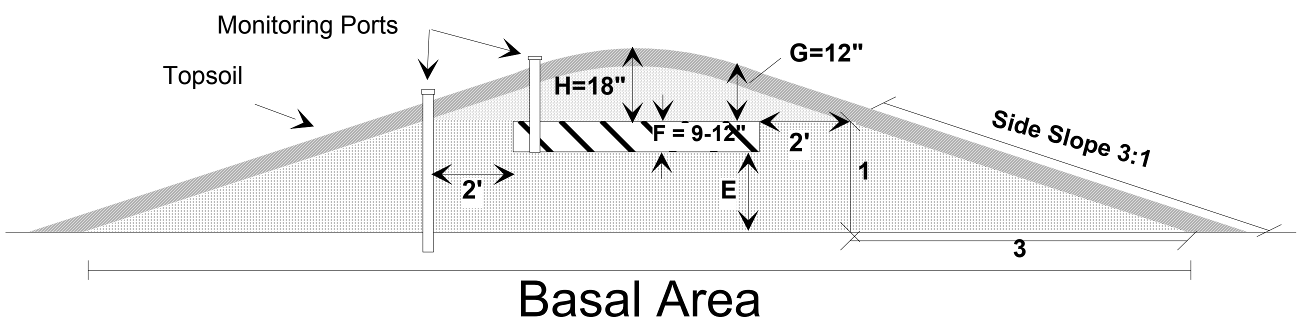


Figure 7 — Cross-Section of Mound System, Showing Minimum Distances (Note Filter Media Outside Bed)

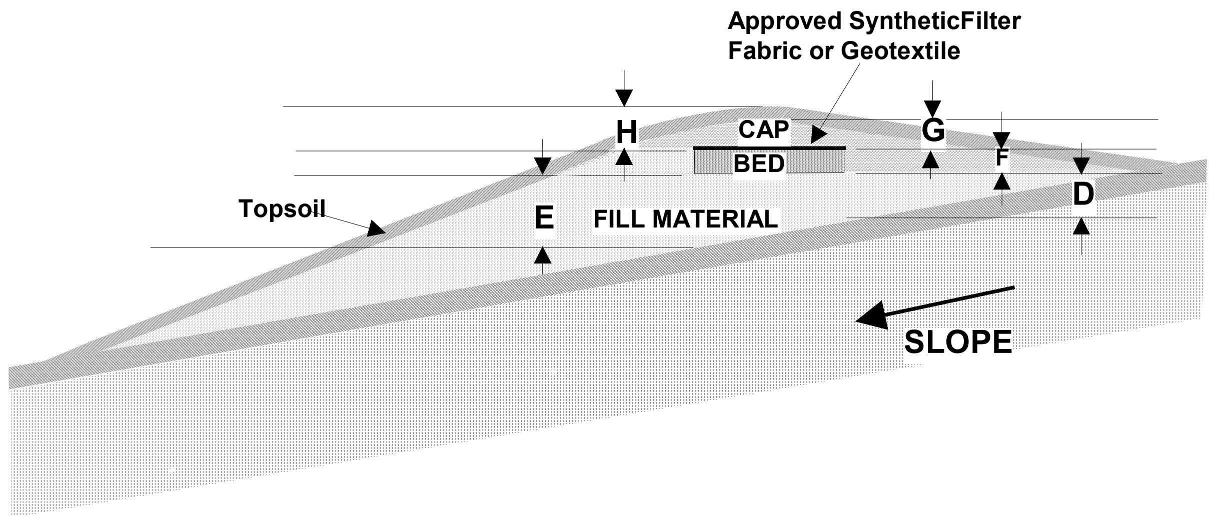


Figure 8 — Basal Area for Filter Media

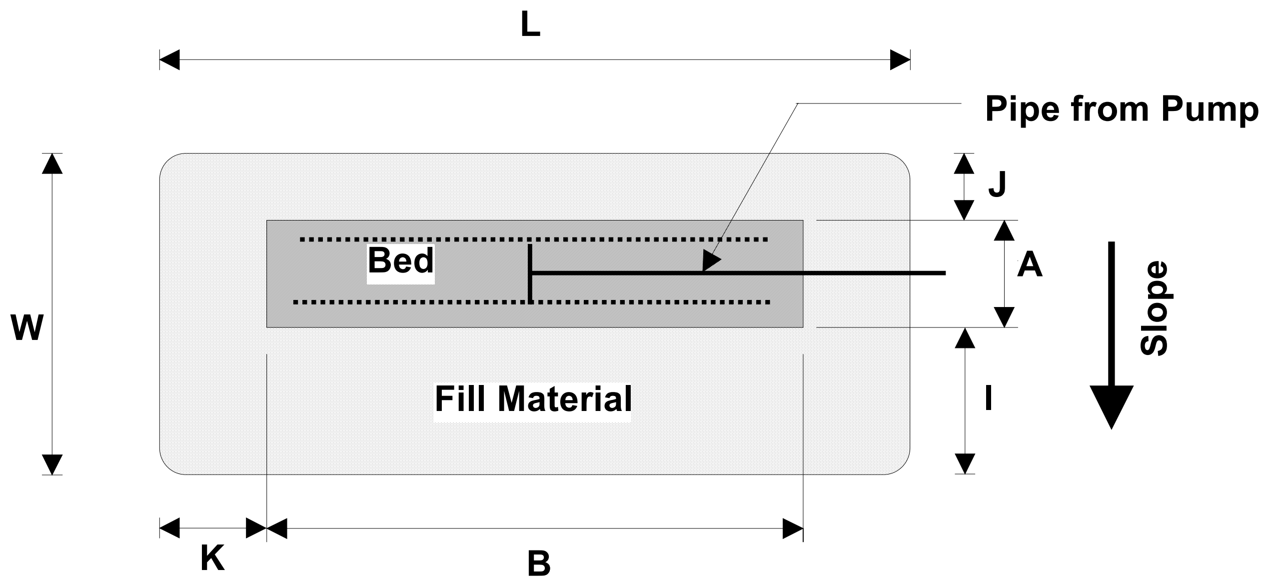
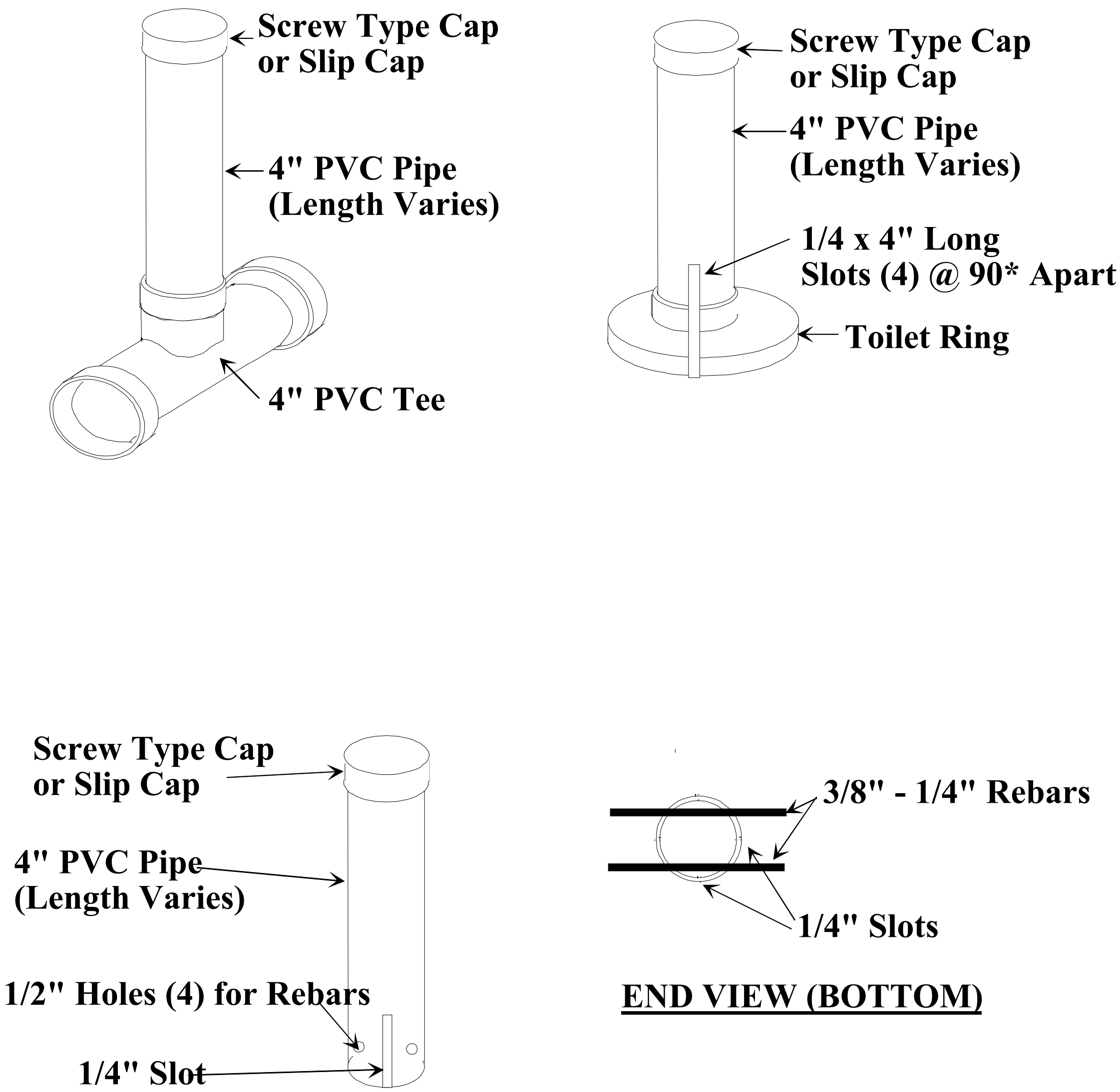


Figure 9 – Inspection / Monitoring Ports



Appendix B

Tables

Table 1. Minimum Setback Requirements

	When the item to be setback from is:	
	Upgradient[1]	Downgradient[2, 3]
Setback distance from **property lines**, **driveways**, **buildings**, **ditches** or **interceptor drains**, or any other development which would either impede water movement away from the mound or channel groundwater to the mound area.	10 feet	30 feet
Setback distance from **well**, **suction line** or **surface water**.	100 feet	100 feet

[1]The item is upgradient when liquid will flow away from it upon encountering a water table or restrictive layer.
[2]The item is downgradient when liquid will flow toward it upon encountering a water table or restrictive layer.
[3]The edge of required basal area.

Table 2. Maximum Bed Width[1]

Type of Restrictive Layer	Available Soil Depth (inches)		
	12 - 18[2]	18 - 24	24 +
Water table or other restrictive layer, excluding non-creviced bedrock.	5 feet	7.5 feet	10 feet
Bedrock, non-creviced.	Not Allowed	7.5 feet	10 feet

[1] The noted bed widths are the maximum cumulative widths permitted for one or more beds on the same downhill plane on a single parcel.

[2] Systems on 12-18 inches of soil may be allowed provided pre-treatment consisting of a system meeting all parameters for Treatment Standard 2 is provided prior to the mound.

Table 3. Downslope and Upslope Width Corrections (Multipliers) For Mounds On Sloping Sites (3:1 Side slopes)

Slope as a percentage	Downslope (I) Correction Factor	Upslope (J) Correction Factor
0	1.00	1.00
2	1.06	0.94
4	1.14	0.89
6	1.22	0.85
8	1.32	0.81
10	1.44	0.77
12	1.58	0.74
14	1.74	0.71
16	1.95	0.68
18	2.21	0.66
20	2.55	0.64

Appendix B (Continued)

Table 4 - Infiltration/Loading Rates for Sizing Basal Area for Mound Systems[1]

SOIL TYPE	SOIL TEXTURAL CLASSIFICATION DESCRIPTION	LOADING RATE gal./sq. ft./day
1A	Very gravelly[2] coarse sands or coarser, extremely gravelly[3] soils.	Varies according to system selected to meet Treatment Standard 2 [4]
1B	Very gravelly medium sands, very gravelly fine sands, very gravelly very fine sands, very gravelly loamy sands.	Varies according to soil type of the non-gravel portion [5]
2A	Coarse sands (includes the ASTM C-33 sand).	1.2
2B	Medium sands.	1.0
3	Fine sands, loamy coarse sands, loamy medium sands.	0.8
4	Very fine sands, loamy fine sands, loamy very fine sands, sandy loams, loams.	0.6
5	Silt loams that are porous and have well-developed structure.	0.45
6	Other silt loams, sandy clay loams, clay loams, silty clay loams.	0.2

[1] Compacted soils, cemented soils, and/or poor soil structure may require a reduction of the loading rate or make the soil unsuitable for conventional OSS systems.
[2] Very Gravelly = >35% and <60% gravel and coarse fragments, by volume.
[3] Extremely Gravelly = >60% gravel and coarse fragments, by volume.
[4] Due to the highly permeable nature of type 1A soil, only alternative systems, which meet or exceed Treatment Standard 2 can be installed. However, a conventional gravity system may be used if it meets all criteria listed under WAC246-272-11501(2)(h). The loading rate for these systems is provided in the appropriate guideline.
[5] The maximum loading rate listed for the soil described as the non-gravel portion is to be used for calculating the absorption surface area required. The value is to be determined from this table. The filter media loading rate for mound systems is 1.0 gallons/ft^2/day. Therefore, the loading rate for the basal area will not exceed this loading rate.

Appendix C

Mound Design Process

Design of a mound system can be divided into five major steps:

(The letters for the various dimensions correlate with those in Figures 5 and 6.)

Step 1. Site / Soil Evaluation—Evaluate the site and soil characteristics to determine that a mound system is appropriate sewage treatment and disposal technology for the site and the project,

Step 2. Daily Wastewater Load / Pre-treatment Device Determination—Identify the daily wastewater load and the needed level of wastewater pre-treatment (septic tank or other pre-treatment unit).

Daily design flow (gal/day) = Number of bedrooms x 120 gal/day.

Step 3. Configure and Dimension the Mound—Configure and dimension the mound:

- size the infiltration area (bed) within the filter media,
- size the mound height components,
- size the filter media length and width,
- size the basal area,

The configuration of the mound system responds to the slope, shape, size, and feature characteristics of the site.

> If the site does not permit the design of a "long and narrow" mound along the contours of the site, other on-site sewage treatment and disposal technology must be selected. Mound systems are only suitable for sites where all of the design and siting criteria can be satisfactorily met.

3a. Sizing the Infiltration (Bed) Area—

$$\text{Infiltrative Surface (Bed) Area } (ft^2) = \frac{\text{Daily design flow (gal/day)}}{1.0 \text{ gallons}/ft^2/\text{day}}$$

The bed dimensions (see Figure 8) are calculated as follows:

Bed width (A) = Dependent on soil depth. See Table 2

$$\text{Bed length (B)} = \frac{\text{Required bottom infiltrative surface area}}{\text{Bed width (A)}}$$

3b. Determining Mound Height—The mound height consists of:

- the filter media depth below the bottom of the bed (D & E),
- the infiltrative bed depth (F), and
- the cap and topsoil depth (G & H).

. **Filter Media Depth (D & E)**—

Filter media depth below upslope edge of bed (D) = 1 to 2 feet

Filter media depth below downslope edge of bed (E) = 1 to 2 feet + [% natural slope as a decimal x width of bed (A)]

Bed Depth (F)—

Bed depth (F) = 9 inches (minimum for 1-inch lateral)

Cap and Top Soil (G & H)—

Unsettled cap and topsoil depth at bed center (H) = 18 inches.

Unsettled cap and topsoil depth at bed edges (G) = 12 inches.

3c. Filter Media Length and Width—The length and width of the filter media are dependent upon the length and width of the infiltration area, filter media depth and side slopes of the filter media (no steeper than 3:1).

Filter Media Length (L) = Length of bed (B) + [2 X end slope (K)]

End slope (K) = Filter media depth at center ($\frac{D + E}{2}$ + F + H) X horizontal gradient of selected side slope (3 if 3:1 side slope)

Filter Media Width (W) = Upslope width (J) + downslope width (I) + width of bed (A)

Upslope width (J) = Filter media depth at upslope edge of bed (D + F + G) horizontal gradient of side slope (3 if 3:1) x slope correction factor (see Table 3)

Downslope width (I) = Filter media depth at downslope edge of bed (E + F + G) x horizontal gradient of side slope (3 if 3:1) x slope correction factor (see Table 3)

These calculations should result in the filter media extending at least two feet horizontally from the top edges of the bed as noted in Figure 7. Check to see that this is done.

3d. Basal Area— For level sites, the total basal area [length of filter media (L) x width of filter media (W)] beneath the filter media is available for effluent absorption into the soil. See Figure 8. For sloping sites, the only available basal area is the area beneath the bed (A x B) and the area immediately downslope from the bed [bed length (B) x downslope width (I)]. It includes the area enclosed by [B x (A + I)]. See Figure 8b. The upslope and end slopes will transmit very little of the effluent on sloping sites, and are therefore disregarded.

It is important to compare the required basal area to the available basal area. The available basal area must equal or exceed the required.

Basal area required = $\frac{\text{Daily flow}}{\text{Infiltration rate of original soil}}$

Basal area available = B x (A + I) on sloping site or
= L x W on level site.

If sufficient area is not available for the given design and site conditions, corrective action is required to increase the perimeters of the filter media area. The preferred method to increase basal area is to lengthen the bed rather than simply extending the toe of the filter media. Again, be advised that if a mound can not be designed and laid-out "long and narrow" other enhanced treatment technologies should be selected rather than err designing or locating a mound system.

Step 4. Design the Distribution Network—Design, layout, and installation of the pump chamber-to-mound transmission line must consider, and satisfactorily address, the potential for channeling groundwater or surface water to either the mound or the pump chamber causing infiltration-related problems.

Step 5. Construction Plan / Owner's Manual—Develop the site-specific construction plan and owner's manual. The mound system, including the area around the base and downslope, must be protected to prevent damage caused by vehicular, livestock, or excessive pedestrian traffic.

Appendix D

Mound Design Examples

EXAMPLE 1: SHALLOW PERMEABLE SOIL

Site Conditions:

Slope - 6%
Parcel size - 2 acres
Native soil - silt loam, 27 inches deep to hardpan
Water table - 25 inches
Home size - 3 bedrooms

Step A: Daily Wastewater Load

Daily flow = # bedrooms x Recommended 120 gal/day = 3 x 120 gal/day = 360 gal.

Step B: Design of the Infiltration Area

1. **Size the infiltration area**

a. Infiltration rate of required filter media = $\underline{1.0\ gal/ft^2/day}$

b. Bottom area of bed = $\dfrac{\text{estimated daily flow}}{\text{infiltration rate of filter media}}$

$= \dfrac{360\ gal/day}{1.0\ gal/ft^2/day}$

$= \underline{360\ ft^2}$

2. **System configuration**

a. Bed width (A) = Select 6 feet. 10 feet could have been selected but wasn't due to concerns of the tight soils and relatively shallow slope.

b. Bed length (B) = $\dfrac{\text{Required bottom infiltrative surface area}}{\text{Selected bed width}}$

$= \dfrac{360\ ft^2}{6\ ft}$

$= \underline{60\ ft.}$

Step C: Design the Entire Mound

1. **Filter media height**

a. Depth of filter media

1) Depth at upslope edge of bed (D) = 1 foot (1 foot selected because the native soils were not excessively permeable, there was no creviced bedrock below the top 24 inches, there were at least 24 inches of original soil.)

2) Depth at downslope edge of bed (E) = 1 foot + (% of natural slope as a decimal) X [width of bed (A)]

= 1 + (.06) (6)

= 1.4 feet

b. Bed depth (F) = .75 feet (anticipate 1 inch lateral)

c. Cap and top soil

1) Unsettled cap and topsoil depth at center of bed (H) = 18 inches

2) Unsettled cap and topsoil depth of bed edges (G) = 12 inches

Approximately 6-8 inches of each of the above original unsettled cap and topsoil depths would consist of topsoil, with the remainder being suitable cap material.)

2. **Filter media length and width**

a. filter media length

Endslope (K)= (filter media depth at center) X (horizontal gradient of selected side slope)

= [(D+E)/2 + F + 1.5] X selected horizontal gradient

= [(1.0+1.4)/2 + 0.75 + 1.5] X 3

= 10.4 feet

filter media length (L) = length of bed (B) + [2 X endslope (K)]

= 60 + [(2) (10.4)]

= 80.8 ft.

b. filter media width

Upslope width (J) = filter media depth at upslope edge of bed (D+F+G)
X horizontal gradient of sideslope
X slope correction factor (Table 3)

= (1.0 + 0.75 + 1.0) (3) (.85)

= 7.0 feet

Downslope width (I)= filter media depth at downslope edge of bed (E+F+G)

X horizontal gradient of sideslope X slope correction factor (Table 3)

= (1.4 + 0.75 + 1.0) (3) (1.22)

= 11.5 feet

filter media width (W) = upslope width (J) + downslope width (I) + width of bed (A)

= 7.0 + 11.5 + 6

= 24.5 feet

3. **Check the basal area**

On sloping sites the effective basal area is considered to be that area below and downslope of the bed [B x (A+J)].

a) Basal area required = $\frac{\text{daily flow}}{\text{infiltration rate of original soil}}$

$= \frac{360}{0.45}$

$= 800\ ft^2$

b) Basal area available = B x (A+I)

= (60) (6 + 11.5)

$= 1050\ ft^2$

Sufficient area is available. If it wasn't, the downslope width (I) must be increased or the mound made longer until sufficient area becomes available.

Step D: Design of the Distribution Network ? See Recommended Standards and Guidance for Pressure Distribution (DOH)

Appendix D (Continued)

Mound Design Examples

EXAMPLE 2: EXCESSIVELY PERMEABLE SOILS

Site Conditions:

Slope - 6%
Parcel size - 1 acre
Native soil - sandy gravel, mostly coarse sands from surface to at least 6 feet
Water table - not within 6 feet of surface
Home size - 3 bedrooms

Step A: Daily Wastewater Load

3 bedrooms x 120 gal/day = 360 gallons

Step B: Design of the Infiltration Area

1. **Size the infiltration area**

a. Infiltration rate of required filter media = 1.0 gal/ft^2/day

b. Bottom area of bed = $\frac{360 \text{ gal/day}}{1.0 \text{ gal/ft}^2\text{/day}}$ = 360 feet

2. **System configuration**

a. Bed width (A) = Select 10 feet.

b. Bed length (B) = $\frac{360 \text{ ft}^2}{10 \text{ ft}}$ = 36 feet

Step C: Design the Entire Mound

1. **Filter media height**

a. Depth of filter media

1) At upslope edge of bed (D) = 2 feet (2 feet because the top 24 inches are excessively permeable).

2) Depth at downslope edge of bed (E) = 2 feet + (% of natural slope as a decimal) X [width of bed (A)]

= 2 + (.06) (10)

= 2.6 feet

b. Bed depth (F) = .75 feet (anticipate 1 inch lateral)

c. Cap and top soil

1) Settled cap and topsoil depth at center of bed (H) = 18 inches

2) Settled cap and topsoil depth of bed edges (G) = 12 inches

(Approximately 6-8 inches of each of the above original unsettled cap and topsoil depths would consist of topsoil, with the remainder being suitable cap material.)

2. **Filter media length and width**

a. filter media length

Endslope (K) $= [\frac{(2.0+2.6)}{2} + 0.75 + 1.5]\ (3)$

$= \underline{13.7 \text{ feet}}$

filter media length (L) = 36 + (2) (13.7)

$= \underline{63.4 \text{ ft.}}$

b. filter media width

Upslope width (J) = (2.0 + 0.75 + 1.0)(3)(.85)

$= \underline{9.6 \text{ feet}}$

Downslope width (I) = (2.6 + 0.75 + 1.0)(3)(1.22)

$= \underline{15.9 \text{ feet}}$

filter media width (W) = 9.6 + 15.6 + 10

$= \underline{35.2 \text{ feet}}$

3. **Check the basal area**

a. Basal area required $= \frac{360 \text{ gal/day}}{1.0 \text{ gal/ft}^2\text{/day}} = \underline{360 \text{ ft}^2}$

b. Basal area available = (63.4)(10 + 15.9) = $\underline{1642.06 \text{ ft}^2}$

There is sufficient area available.

Step D: Design of the Distribution Network ? See Recommended Standards and Guidance for Pressure Distribution (DOH)

Appendix D (Continued)

Mound Design Examples

EXAMPLE 3: SHALLOW PERMEABLE SOILS

Site Conditions:

Slope	-	8%
Parcel size	-	5 acres
Native soil	-	20 inches of sandy loam to consolidated glacial till
Water table	-	none noted - water flows downslope on the till layer during periods of high rainfall
Home size	-	3 bedrooms

(After careful and detailed investigation, justification was provided which indicated that the effluent would satisfactorily flow away from site in the 20 inches of soil and that breakouts would not occur downslope that could cause any nuisance or public health hazard potential. A long narrow system parallel to the slope contours is necessary because of the slope and the shallow soil.)

Step A: Daily wastewater load

3 bedrooms x 120 gal/day = 360 gallons

Step B: Design of the Infiltration Area

1. **Size the infiltration area**

   a. Infiltration rate of medium sand = 1.0 gal/ft^2/day

   b. Bottom area of bed = $\frac{360 \text{ gal/day}}{1.0 \text{ gal/ft}^2\text{/day}} = \underline{360 \text{ ft}^2}$

2. **System configuration**

   a. Bed width (A) = Select 3 feet

   b. Bed length (B) = $\frac{360 \text{ ft}^2}{3 \text{ ft}}$ = 120 feet

Step C: Design the Entire Mound

1. **Filter media height**

   a. Depth of filter media

      1) At upslope edge of bed (D) = 1.33 feet (16 Inches)
      (Because only 20 inches of original soil exist, 16 inches of filter media need to be added below bed to ensure that a separation of 3 feet exists)

      2) At downslope edge of bed (E) = 1.33 + (.08)(3) = 1.6 feet natural slope as a decimal) X (width of bed)

   b. Bed depth (F) = 0.75 feet

c. Cap and topsoil

1) Settled depth at center of bed (H) = 18 inches

2) Settled cap at bed edges (G) = 12 inches

2. **Filter media length and width**

a. filter media length

Endslope (K) $= \left[\frac{(1.3+1.6)}{2} + .75 + 1.5\right](3) = \underline{11.1 \text{ feet}}$

Filter media length (L) = 120 + (2)(11.1) = 142.2 feet

b. **Filter media width**

Upslope width (J) = (1.3 + 0.75 + 1.0)(3)(.8) = 7.4 feet

Downslope width (I) = (1.6 + 0.75 + 1.0)(3)(1.32) = 13.3 feet

Filter media width (W) = 7.4 + 13.3 + 3 = 23.7 feet

3. **Check the basal area**

a. Basal area required $= \frac{360 \text{ gal/day}}{0.6 \text{ gal/ft}^2\text{/day}} = \underline{600 \text{ ft}^2}$

b. Basal area available = (120)(3 + 13.3) = $\underline{1956 \text{ ft}^2}$

There is sufficient area available.

Step D: Design of the Distribution Network ? See Recommended Standards and Guidance for Pressure Distribution (DOH)

Appendix E

Mound Worksheet / Checklist

_______ A. **DAILY WASTEWATER FLOW**

Daily wastewater flow = # bedrooms X 120 gal/day/bedroom (Minimum)
= __________ X 120 gal/day/bedroom

_______ B. **DESIGN OF THE INFILTRATION AREA**

1. **Size the infiltration area**

a. Infiltration rate of filter media: 1.0 gal/ft^2/day

b. Bottom area of bed = $\frac{\text{Daily wastewater flow}}{1.0 \text{ gal/ft}^2\text{/day}}$

= ____________ gal/day

1.0 gal/ft^2/day

= ____________ ft^2

2. **Bed configuration**

a. Bed width (A) = __________________ ft

b. Bed length (B) = $\frac{\text{Bottom area of bed}}{\text{Width of bed}}$ = Bed length

= ____________ ft^2

____________ ft

= ____________ ft

_______ C. DESIGN THE ENTIRE MOUND

1. **Filter media height**

a. Filter media depth

1) Depth at upslope edge of bed (D) = 1 to 2 ft depending on filter media and original soil

= ____________ ft

2) Depth at downslope edge of bed (E)

= Depth at upslope edge of bed + (% slope expressed as decimal X bed width)

= D + (% slope expressed as decimal X A)

= ____________ ft + (____________ X ____________ ft)

= ____________ ft

b. Bed depth (F) = 0.75 ft (usually for 1 in. laterals)

= ____________ ft

c. Cap and topsoil

1) Depth at bed center (H) = 18 inches

2) Depth at bed edges (G) = 12 inches

2. **Filter media length**

a. Endslope width (K) = Total filter media depth at bed center X horizontal gradient of sideslope

$$K = \left[\left(\frac{D+E}{2}\right) + F + H\right] \times horizontal\ gradient$$

$$= \left[\left(\frac{\_\_\_\_\ ft + \_\_\_\_\ ft}{2}\right) + \_\_\_\_\ ft + \_\_\_\_\ ft\right] \times \_\_\_\_$$

b. Filter media length (L) = Bed length + (2 X endslope width)

= B + 2K

= _____ ft + (2 X _____ ft)

= ______ ft

3. **Filter media width**

a. Upslope width (J) =filter media depth at upslope edge of bed X horizontal gradient of sideslope X slope correction factor

= (D + F + G) X horizontal gradient X slope correction factor

= (_____ ft + _____ ft + _____ft) X _____ X _____

= ______ ft X _____ X _____

= ______ ft

b. Downslope width (I) = filter media depth at downslope edge of bed X horizontal gradient of sideslope X slope correction factor

= (E + F + G) X horizontal gradient X slope correction factor

= (_____ ft + _____ ft + _____ft) X _____ X _____

= ______ ft X _____ X _____

= ______ ft

c. Filter media width (W) = upslope width + Bed width + Downslope width

= J + A + I

= _____ ft + _____ ft + _____ft

= ______ ft

4. **Check the basal area**

a. Basal area required = $\dfrac{\text{Daily rate}}{\text{Infiltration rate of original soil}}$

$$= \dfrac{\text{\_\_\_\_\_\_\_\_\_\_ gal/day}}{\text{\_\_\_\_\_\_\_\_\_\_\_\_ gal/ft}^2\text{/day}}$$

= ____________ ft^2

b. Basal area available — Is it sufficient? _____ YES _____ NO

1) Sloping site = Bed length X (Bed width + Downslope width)

= B X (A + I)

= ______ ft X (_____ ft + _____ ft)

= ______ ft X ______ ft

= ______ ft^2

2) Level site = filter media length X Fill width

= L X W
= ______ ft X _____ ft
= ______ ft^2

Appendix F

Site Preparation and Construction

Construction Procedures—The following is a step by step procedure for mound system construction that has been tried and proven. If these procedures are followed, the potential for future problems should be minimized and the mound system should function properly. Other techniques may also work satisfactorily, but the basic principles of mound system design, construction and operation should not be violated.

1. Check the moisture content of the soil at 7-8 inches deep. If it is too wet, smearing and compaction will result, reducing the infiltration capacity of the soil. Soil moisture can be determined by rolling a soil sample between the hands. If it rolls into a wire, the site is too wet to prepare. If it crumbles, site preparation can proceed. **If the site is too wet to prepare, do not proceed until the soil moisture decreases.**

2. Stake out the mound area on the site according to the system design, so the infiltration bed runs parallel to the contours. Reference stakes offset from the corner stakes are recommended in case corner stakes are disturbed during construction. If the site conditions do not allow for layout according to the approved design, contact the designer and/or the local health officer.

3. Measure the average ground elevation along the upslope edge of the bed or the upper trench and reference this to a benchmark for future use. This is necessary to determine the bottom elevation of the bed.

4. Determine where the pipe from the pump chamber connects to the distribution system in the filter media. The location and size of this transport pipe is determined from the pressure distribution guideline.

5. Trench and lay the effluent pipe from the pump chamber to the mound. Cut and cap the pipe one-foot beneath the ground surface. Lay pipe below frost line or sloping uniformly back to the pump chamber so that it drains after dosing.

Backfill and compact the soil around the pipe to prevent back seepage of effluent along pipe. This step must be done before plowing to avoid compaction and disturbance of the surface.

6. Cut trees to ground level, remove excess vegetation by mowing. Rake cut vegetation if it is, or will become, matted. Prepare the site using a spring-loaded agricultural chisel plow and plowing parallel to contours.

The function of this preparation is to provide a cleared ground surface with a series of vertical channels to enhance transfer of moisture from the sand fill to the original soil, while inhibiting lateral movement at the sand-soil interface. In addition the vertical furrows aid in stabilizing the sand at the sand-soil interface in an inter-locking fashion.

The site should be plowed using a spring loaded agricultural chisel plow, or other acceptable apparatus or method to prepare the soil before constructing the mound system. Shallow hand spading the surface is also an acceptable alternative and may be the preferred method on some sites. Rototilling is <u>not</u> an acceptable substitute and <u>must not</u> be done.

The important point is that a rough, unsmeared surface should be left, especially in fine textured soils. Careful observation is required to assure that the soil moisture content is not so high that the soil surface is smeared by the action of the plow. Plowing should not proceed until the soil is sufficiently dry so as not to smear in the plowing process.

If stumps remain, care must be taken in preparing the site. The sod layer should be broken up, yet the topsoil should not be pulverized. The objective of this step is to break up any surface mat that could impede the vertical flow of liquid into the native soil.

Immediate construction after plowing is desirable. Avoid rutting and compaction of the plowed area by traffic. If it rains after the plowing is completed, wait until the soil dries out before continuing construction.

7. Reset the corner stakes, if necessary, using the offset reference stakes and locate the bed or trench areas by staking their boundaries.

8. Extend the transport pipe from the pump chamber (which had previously been cut off) to several feet above the ground surface.

9. Install one or more standpipes (4 inch PVC with the bottom foot perforated, rebar and with gravel or a geotextile around the perforations). At least one must be in the downslope portion of the mound with the bottom at the original surface and the top extending above final grade where it can be capped. Another could be located in the bed extending only from the bottom of the bed to above the final grade. The standpipes allow observations to be made of the water levels. Slotting the caps will facilitate removing the caps to allow access.

10. Place the filter media that has been properly selected around the edge of the plowed area. Keep the wheels of trucks off plowed areas. Avoid traffic on the downslope side of the mound system. Work from the end and upslope sides. This will avoid compacting the soils on the downslope side, which, if compacted, would affect lateral movement away from the mound and possibly cause surface seepage at the toe of the mound.

11. Move the filter media into place using a small track-type tractor with a blade. Do not use a tractor/backhoe having rubber-tired wheels. Always keep a minimum of 6 inches of filter media beneath tracks to prevent compaction of the natural soil.

12. Place the filter media to the required depth, i.e., to the top of the bed. Shape sides to the desired slope.

13. With the blade of the tractor form the infiltration bed. Hand level the bottom of the bed to within $\pm$1/2 inch.

14. Place the coarse aggregate in the bed. Level the aggregate to the design depth.

15. Place the distribution pipes, as determined from the pressure distribution guidelines, on the aggregate. Connect the manifold to the transport pipe. Slope the manifold to the transport pipe. Lay the laterals level, removing rises and dips.

16. Pressure test the distribution system for uniformity of flow.

17. Place 2 in. of aggregate over the distribution pipe.

9. Place an approved geotextile material over the aggregate.

10. Place the soil for the cap <u>and topsoil</u> on the top of the bed. This may be a subsoil or a topsoil. An initial depth of 18 inches in the center and 12 inches at the outer edge of the bed is desired. This creates a slope that assists the surface run-off of precipitation. Also, this layer provides some frost protection. Do <u>not</u> drive over the top of the bed as the distribution system may be damaged.

11. Seed or sod the mound system.

Appendix G

GLOSSARY

Alternative System: an on-site sewage system other than a conventional gravity system or a conventional pressure distribution system. Properly operated and maintained, alternative systems provide equivalent or enhanced treatment performance compared to conventional gravity systems. *[WAC 246-272-01001]*

Approved: a written statement of acceptability, in terms of the requirements in this chapter, issued by the local health officer or the department. *[WAC 246-272-01001]*

ASTM: American Society for Testing Materials

Basal Area: the effective surface area available to transmit the treated effluent from the filter media into the original receiving soils.

Biochemical Oxygen Demand (BOD_5): an index of the amount of oxygen that will be consumed by the decomposition of organic matter in a wastewater. This is the result of a laboratory analysis that consists of measuring the initial dissolved oxygen concentration, incubating the sample for five days at 68^o F, then measuring the final dissolved oxygen. The difference in dissolved oxygen concentration corrected for the initial dilution and sample volume is called the BOD_5. The BOD_5 test is one of the commonly used indicators of wastewater strength.

Carbonaceous Biochemical Oxygen Demand ($CBOD_5$): The concentration of oxygen expressed as mg/L utilized by microorganisms by non-nitrogenous oxidation of organic matter during a 5-day incubation period at a temperature of 68^0F. Whereas the BOD_5 test measures both nitrogenous and non-nitrogenous biological oxygen depletion (See BOD_5) Standard Methods for the Examination of Water and Wastes Eighteenth edition recommends that nitrification inhibition be included as a step during sample preparation if measuring "biologically treated effluents, samples seeded with biologically treated effluents and river waters". The inhibitor keeps dissolved oxygen from being consumed to nitrify NH_3 to NO_2 or NO_3 instead of oxidizing carbon through biological respiration. Since the intent for measuring "Biochemical Oxygen Demand " is to determine organic strength, this can eliminate one of the sources of interference for the analysis. When the inhibition step is included with the 5 day Biochemical Oxygen Demand test, Standard Methods requires the results to be identified as $CBOD_5$ instead of BOD_5.

Calculating for the percent reduction of organic waste constituents is more accurate if $CBOD_5$ is used instead of BOD_5 for the parameter values. The reason is, influent nitrogen typically exists as ammonia (NH_3), but is transformed to nitrate (NO_3) by the aerobic process, especially if the system is operated in the extended aeration mode (>20 day MCRT). The $CBOD_5$ can be up to 80% of the total BOD_5 of an influent sample, a difference of 20%. Since ATUs generally achieve full nitrification, difference between BOD_5 and $CBOD_5$ for effluent samples should be far less significant. The reason being, a sample of nitrified effluent subjected to the Biochemical Oxygen Demand analysis is unlikely to exhibit additional dissolved oxygen loss during the incubation period due to nitrification. Even though differences between ATU effluents tested according to the two different methods should be relatively minor, care should be taken when drawing any comparisons between products using these dissimilar measures of organic strength. If possible, for a product measured according to the bio-chemical demand method instead of strictly the biological demand method, other parameters should be evaluated to determine if the system appeared to be achieving effluent nitrification during the sample period.

Conventional Gravity System: an on-site sewage system consisting of a septic tank and a subsurface soil absorption system with gravity distribution of the effluent. *[WAC 246-272-01001]*

Cover Material: the material used to cover a mound system, usually selected on its availability, cost, and ability to support vegetation, transfer oxygen, and shed water. Includes the Cap and the Topsoil.

Designer: See Licensed On-Site Sewage System Designer

Design Flow: the volume of wastewater predicted to be generated by occupants of a structure. For residential dwellings, this volume is calculated by multiplying the number of bedrooms by the estimated number of gallons per day (gpd) per bedroom, using either the minimum state design standard (120 gpd) or the locally established minimum standard (such as 150 gpd).

Development: the creation of a residence, structure, facility, mobile home park, subdivision, planned unit development, site, area, or any activity resulting in the production of sewage. *[WAC 246-272-01001]*

Department: the Washington state department of health. *[WAC 246-272-01001]*

Dosing Tank / Chamber: a tank which collects treated effluent and periodically discharges it into another treatment / disposal component, depending upon the needs and design of the particular on-site sewage system.

Dosing: the application of wastewater to a treatment or disposal system in discreet amounts over a definite time period, as opposed to an unregulated flow.

Drain Rock: clean, washed gravel, varying in size from ¾ inch to 2 ½ inches.

Drainfield (Conventional): an area in which perforated piping is laid in drain rock-packed trenches, or excavations (seepage beds) for the purpose of distributing the effluent from a wastewater treatment unit into original, undisturbed soil.

Effluent: liquid discharged from a septic tank or other on-site sewage system component. *[WAC 246-272-01001]*

Engineer: See Licensed Professional Engineer

Excessively Permeable Soils: Type One soils.

Expansion: a change in a residence, facility, site, or use that:

(a) causes an on-site sewage system to exceed its existing treatment or disposal capability, for example, when a residence is increased from two to three bedrooms or a change in use from an office to a restaurant; or
(b) reduces the treatment or disposal capability of the existing on-site sewage system or the reserve area, for example, when a building is placed over a reserve area.
[WAC 246-272-01001]

Experimental System: any alternative system:
(a) without design guidelines developed by the department; or
(b) a proprietary device or method which has not yet been evaluated and approved by the department.
[WAC 246-272-01001]

Failure: a condition of an on-site sewage system that threatens the public health by inadequately treating sewage or creating a potential for direct or indirect contact between sewage and the public. Examples of failure include:
(a) sewage on the surface of the ground;
(b) sewage backing up into a structure caused by slow absorption of septic tank effluent;
(c) sewage leaking from a septic tank, pump chamber, holding tank, or collection system;
(d) cesspool or
(e) s where evidence of ground water or surface water quality degradation exists; or
(f) inadequately treated effluent contaminating ground water or surface water.
(g) noncompliance with standards stipulated on the permit.
[WAC 246-272-01001]

Fecal Coliform (Bacteria): coliform bacteria specifically originating from the intestines of warm-blooded animals, used as a potential indicator of ground water and/or surface water pollution.

Filter Media: sand meeting specific criteria regarding particle size and installation technique to ensure adequate wastewater treatment. ASTM C-33 sand is most frequently the media specified.

Filter: a device or structure for removing suspended solid or colloidal material from wastewater.

Fineness Modulus: a numeric quantity to control the distribution of filter media particle sizes within the specified range for intermittent sand filters. It is calculated by adding the cumulative percents of samples retained on the following screens, divided by 100.

Geotextile: any geotechnical engineering-related permeable textile used with foundations, soil, rock, earth, an integral part of a human-made project, structure, or system, and which serves to lessen the movement of fine soil particles.

Ground water: a subsurface water occupying the zone of saturated soil, permanently, seasonally, or as the result of the tides. Indications of ground water may include:
(a) water seeping into or standing in an open excavation from the soil surrounding the excavation.

(b) spots or blotches of different color or shades of color interspersed with a dominant color in soil, commonly referred to as mottling. Mottling is a historic indication for the presence of groundwater caused by intermittent periods of saturation and drying, and may be indicative of poor aeration and impeded drainage. Also see "Water table".
[WAC 246-272-01001]

Hydraulic Conductivity: the ability of soil to transmit liquids through pore spaces in a specified direction, e.g., horizontally or vertically.

Industrial wastewater: the water or liquid carried-waste from an industrial process. These wastes may result from any process or activity of industry, manufacture, trade or business, from the development of any natural resource, or from animal operations such as feedlots, poultry houses, or dairies. The term includes contaminated storm water and leachate from solid waste facilities. *[WAC 246-272-01001]*

Infiltrative Area: see "Basal Area".

Infiltrative Surface: in drainfields, the drain rock-original soil interface at the bottom of the trench; in mound systems, the gravel-mound sand and the sand-original soil interfaces; in sand-lined trenches/beds (sand filter), the gravel-sand interface and the sand-original soil interface at the bottom of the trench or bed.

Influent: wastewater flowing into an on-site sewage system component such as a septic tank (septic tank influent) or sand filter (sand filter influent).

Installer: a qualified person approved by a local health officer to install or repair on-site sewage systems or components. *[WAC 246-272-01001]*

Local Health Officer: the health officer of the city, county, or city-county health department or district within the state of Washington, or a representative authorized by and under the direct supervision of the local health officer, as defined in chapter 70.05 RCW. *[WAC 246-272-01001]*

May: discretionary, permissive, or allowed. *[WAC 246-272-01001]*

Mound System: a method of on-site sewage treatment and disposal in which a specified sand filter media is laid on top of a properly prepared original soil surface. The distribution system and wastewater infiltration beds are then placed entirely within the filter media at such a level that the desired vertical separation to provide the necessary treatment exists. The original soil provides some additional treatment and is necessary to move the effluent away from the site without surfacing. Not included in this definition are systems where soil fill is used only for cover.

On-site Sewage System (OSS): an integrated arrangement of components for a residence, building, industrial establishment or other places not connected to a public sewer system which:
(a) convey, store, treat, and/or provide subsurface soil treatment and disposal on the property where it originates, upon adjacent or nearby property; and

(b) includes piping, treatment devices, other accessories, and soil underlying the disposal component of the initial and reserve areas.
[WAC 246-272-01001]

Particle Size: the diameter of a soil or sand particle, usually measured by sedimentation or sieving.

Permeable Soil: soil with a textural classification, according to the U.S. Department of Agriculture Soil Conservation Service classification system, of loams or coarser. Soils will be considered excessively permeable when they are coarser than coarse sand.

Person: any individual, corporation, company, association, society, firm, partnership, joint stock company, or any governmental agency, or the authorized agents of any such entities. *[WAC 246-272-01001]*

Performance Standard: a standard used to judge whether predetermined requirements have been met, such as the necessary level of treatment for waste stream, after the completion or initiation of operation. Performance standards generally are in the form of a pre-determined level or concentration of a particular compound or constituent that is allowed in a waste effluent.

Pressure distribution: a system of small diameter pipes equally distributing effluent throughout a trench or bed, as described in the "Guidelines for Pressure Distribution Systems" by the Washington State Department of Health. Also see “Conventional Pressure Distribution”. *[WAC 246-272-01001]*

Proprietary device or method: a device or method classified as an alternative system, or a component thereof, held under a patent, trademark or copyright. *[WAC 246-272-01001]*

Puddling: act of destroying soil structure, usually by disturbing or compacting the soil at high water content, thereby reducing porosity and permeability.

Pump Chamber: a tank or compartment following the septic tank or other pretreatment process which contains a pump, floats and volume for storage of effluent. In timer-controlled pressure distribution systems, this is frequently called a "surge tank" or "equalization tank." If a siphon is used, in lieu of a pump, this is called a "siphon chamber."

Repair: restoration, by reconstruction or relocation, or replacement of a failed on-site sewage system. *[WAC 246-272-01001]*

Reserve area: means an area of land approved for the installation of a conforming system and dedicated for replacement of the OSS upon its failure. *[WAC 246-272-01001]*

Residential Sewage: sewage having the consistency and strength typical of wastewater from domestic households. *[WAC 246-272-01001]*

Restrictive Layer: a stratum impeding the vertical movement of water, air, and growth of plant roots, such as hardpan, clay pan, fragipan, caliche, some compacted soils, bedrock and unstructured clay soils. *[WAC 246-272-01001]*

Sand Filter: a biological and physical wastewater treatment component consisting (generally) of an under drained bed of sand to which pre-treated effluent is periodically applied. Filtrate collected by the under drains is then disposed of by an approved soil absorption system. A septic tank or another approved treatment component can provide pretreatment. An Intermittent Sand

Filter is a sand filter in which pre-treated wastewater is applied periodically providing intermittent periods of wastewater application, followed by periods of drying and oxygenation of the filter bed. A Recirculating Sand (Gravel) Filter is a sand (gravel) filter which processes liquid waste by mixing filtrate with incoming septic tank effluent and recirculating it several times through the filter media before discharging to a final treatment/disposal unit. Sand-Lined Drainfield Trench is a combination of a pressure distribution drainfield and an intermittent sand filter consisting of a two-foot layer of intermittent sand filter media placed directly below the drain rock layer in the pressure distribution drainfield trench. A Bottomless Sand Filter is a special case of a sand-lined drainfield trench installed in a containment vessel and is usually used to utilize more suitable soils high in the soil profile for disposal.

Seepage pit: an excavation more than three feet deep where the sidewall of the excavation is designed to dispose of septic tank effluent. Seepage pits may also be called "dry wells". *[WAC 246-272-01001]*

Septic Tank: a water tight pretreatment receptacle receiving the discharge of sewage from a building sewer or sewers, designed and constructed to permit separation of settleable and floating solids from the liquid, detention and anaerobic/facultative digestion of the organic matter, prior to discharge of the liquid. *[WAC 246-272-01001]*

Sewage: any urine, feces, and the water carrying human wastes including kitchen, bath, and laundry wastes from residences, buildings, industrial establishments or other places. For the purposes of this document, “sewage” is generally synonymous with domestic wastewater. Also see "residential sewage." *[WAC 246-272-01001]*

Shall: means mandatory *[WAC 246-272-01001]*

Slope Stability: the resistance of an inclined surface to failure by sliding or collapsing.

Slowly Permeable Soil: soils with a textural classification, according to the U.S. Department of Agriculture Soil Conservation Service classification system, of silt loams, and some silty clay loams that are well structured.

Soil Compaction: increasing the soil bulk density, and concomitantly decreasing the soil porosity, by the application of mechanical forces to the soil. Results in a soil that retains less water and resists root penetration. Soils with high clay content are more easily compacted than sandy soils.

Soil type: a numerical classification of fine earth particles and coarse fragments as described in 246-272-11001(2)(e). *[WAC 246-272-01001]*

Soil Type 1A: very gravelly coarse sands or coarser, extremely gravelly soils.

Subdivision: a division of land or creation of lots or parcels, described under chapter 58.17 RCW, now or as hereafter amended, including both long and short subdivisions, planned unit developments, and mobile home parks. *[WAC 246-272-01001]*

Subsurface Soil Absorption System - "SSAS": a system of trenches three feet or less in width, or beds between three feet and ten feet in width, containing distribution pipe within a layer of clean gravel designed and installed in original, undisturbed soil for the purpose of receiving effluent and transmitting it into the soil. *[WAC 246-272-01001]*

Suitable Soil: original, undisturbed soil of types 1B through 6.

Surface water: any body of water, whether fresh or marine, flowing or contained in natural or artificial unlined depressions for significant periods of the year, including natural and artificial lakes, ponds, springs, rivers, streams, swamps, marshes, and tidal waters. *[WAC 246-272-01001]*

Timer-Controlled System: a pressure distribution system where the pump on and off times are preset, discrete time periods.

Total Suspended Solids (TSS): suspended solids refer to the dispersed particulate matter in a wastewater sample that may be retained by a filter medium. Suspended solids may include both settleable and unsettleable solids of both inorganic and organic origin. This parameter is widely used to monitor the performance of the various stages of wastewater treatment, often used in conjunction with BOD_5 to describe wastewater strength. The test consists of filtering a known volume of sample through a weighed filter membrane that is then dried and re-weighed.

Treatment Component: a class of on-site sewage system components that modify and/or treat sewage or effluent prior to the effluent being transmitted to another treatment component or a disposal component. Treatment occurs by a variety of physical, chemical, and/or biological means. Constituents of sewage or effluent may be removed or reduced in concentrations.

Treatment Standard 1: a thirty-day average of less than 10 mg/l of BOD_5 and 10 mg/l of total suspended solids and a thirty-day geometric mean of less than 200 fecal coliform/100ml. *[WAC 246-272-01001]*

Treatment Standard 2: a thirty-day average of less than 10 mg/l of BOD_5 and 10 mg/l of total suspended solids and a thirty-day geometric mean of less than 800 fecal coliform/100ml. *[WAC 246-272-01001]*

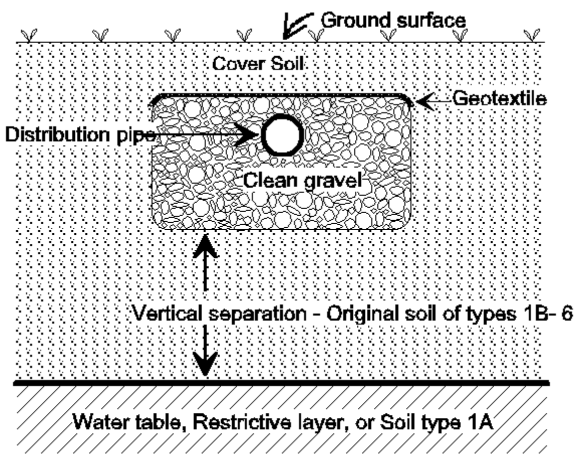
TSS - Total suspended solids: a measurement of the solids that either float on the surface of, or are in suspension in, water or wastewater often used in conjunction with BOD5 to describe wastewater strength.

Uniform Distribution: a method of distribution which results in equal distribution of the effluent throughout the distribution network. This will help assure a vertical unsaturated flow regime. Procedures are explained in detail in the Guidelines for the Design and Use of Pressure Distribution Systems, DOH, 1984.

Uniformity Coefficient, CU: a numeric quantity which is calculated by dividing the size of the opening which will pass 60% of a sample by the size of the opening which will pass 10% of the sample. (symbolically C60/C10=CU)

Vertical Flow: the effluent flow path downward through soil or filter media that involves travel along soil surfaces or through soil pores. This flow can be either saturated or unsaturated. Unsaturated flow follows a tortuous path that allows pathogens and pollutants in the wastewater to come in contact with the microsites in the soil or filter media where treatment by physical, biological, and chemical means occurs. With unsaturated flow all soil pores are primarily filled with air, not water. With saturated flow all soil pores are filled with water. Oxygen is excluded, and contact time may be insufficient for retention or treatment to occur.

Vertical Separation: the depth of unsaturated, original, undisturbed soil of Soil types 1B - 6 between the bottom of a disposal component and the highest seasonal water table, a restrictive layer, or Soil Type 1A.



[WAC 246-272-01001]

Water table: the upper surface of the ground water, whether permanent or seasonal. Also see "ground water." *[WAC 246-272-01001]*

Wastewater Treatment Unit: a unit designed, constructed, and installed to stabilize liquid waste by biochemical and physical action.

Wastewater: water-carried human excreta and/or domestic waste from residences, buildings, industrial establishments or other facilities. (See SEWAGE.)

Appendix H

Mound Filter Media Specification

The standard method to be used for performing particle size analysis must comply with one of the following:

1. the sieve method specified in ASTM C-136 and ASTM C-117
2. the method specified in Soil Survey Laboratory Methods and Procedures for Collecting Soil Samples, Soil Survey Investigation Report #1, U.S. Department of Agriculture, 1984.

Information concerning these methods can also be obtained from Methods of Soil Analysis, Part I, 2nd edition; A. Klute, editor, ASA Monograph #9, American Society of Agronomy, Madison, WI, 1986.

The sand must meet each of the following specifications:

1. The filter media must meet the following particle size gradation: (Source: ASTM C-33, Specification for Fine Aggregate)

Sieve	Effective Particle Size	% Passing (by Weight)
3/8 in.	9.5 mm	100%
No. 4	4.75 mm	95-100%
No. 8	2.36 mm	80-100%
No. 16	1.18 mm	50-85%
No. 30	0.6 mm	25-60%
No. 50	0.3 mm	10-30%
No. 100	0.15 mm	2-10%

[For No. 200 sieve, see note 4.]

2. The sand must have not more than 45% passing any one sieve and retained on the next consecutive sieve of those shown above.

3. The fineness modulus must not be less than 2.3 nor more than 3.1. The fineness modulus is defined as the sum of the cumulative percentages retained in the sieve analysis, divided by 100, for the sieve sizes shown above.

4. The limit for material that can pass the No. 200 sieve is no more than 3%.